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Golder Associates

TECHNICAL MEMORANDUM #4

TO: Mr. Steve Lackey, Barneys Canyon Mine DATE: September 15, 1995

CC: Mr. D. Kerstiens, Barneys Canyon Mine
Mr. L. Kunzler, State of Utah, Div. of Oil, Gas, and Mining
Mr. T. Munson, State of Utah, Div. of Oil, Gas, and Mining

FR: David R. Morrey

RE: SPECIFICATIONS FOR THE SURFACE RESTORATION OF THE 6300 WASTE ROCK DUMP AT BARNEYS CANYON MINE

1.0 Introduction

On August 24, 1995, site inspections of reclamation trials and areas of rehabilitated waste rock were undertaken. Those present during the field visit included:

- Mr. D. Kerstiens (General Manager, Barneys Canyon Mine);
- Mr. S. Lackey (HSEQ Manager, Barneys Canyon Mine);
- Mr. L. Kunzler (Reclamation Specialist, State of Utah);
- Mr. T. Munson (Senior Reclamation Hydrologist, State of Utah); and,
- Dr. D. Morrey (Director, Environmental Services, Golder Associates Inc.)

Areas inspected included:

- Bench (football field) trials at Barneys Canyon Pit;
- 6400/6500 rock dump; and,
- Reclaimed slopes at South Barneys Canyon South (SBCS).

The aim of the inspection was to review the performance of reclamation strategies applied to experimental areas at the pit and 6400/6500 rock dumps, and at SBCS. In so doing, refinements would be made to the specifications for chemical amendment, vegetation establishment and erosion protection, on the 6300 rock dump, which is scheduled for reclamation in the fall of 1995.

This technical memorandum summarizes the observations recorded during the site inspections. Specifications for the surface reclamation of the 6300 rock dump are provided in draft form, for approval by Barneys Canyon Mine and the Division of Oil, Gas, and Mining.

2.0 "Football Field" Pit Bench

Monitoring records over the past 3 years indicate that commercial varieties of native and naturalized plant species can be established on suitably amended waste rock and topsoil. The performance of individual species depends upon organic matter amendments, whether or not topsoil has been placed over the waste rock, as well as, on the fertilization treatments used. The timing of nitrogen applications to seeded surfaces also has a significant effect upon species performance and final vegetation composition. Areas of the football field trial and SBCS treated with sludge produced results which indicate it may be a viable replacement for other soil amendments and fertilizers.

2.1 Surface Amendments

The most extensive vegetation cover and highest species richness (number of species per unit area) were observed on topsoiled areas. No significant differences were evident between 6-inch and 12-inch topsoil depths. Lowest cover and species richness were recorded on waste rock which remained uncapped and untreated with organic matter. Results recorded on sludge treated cells indicate a potential for successfully establishing adequate vegetation cover on waste rock without topsoil. In cells where organic matter had been incorporated into the waste rock surface, vegetation cover was acceptable, but species richness was less (due to weeds being absent), and characterized by the predominant species *Secale cereale*, a temporary nurse crop. The dominance of *S. cereale* can, however, be controlled by adjusting the application rates. The success, seen here and in other studies, with the use of sewage sludge, is sufficiently positive to warrant further investigation into its use at this site.

It was concluded, therefore, that in order to achieve the required minimum cover of 0.7 x background (approximately 46 percent), a minimum of sludge treatment will be necessary. To achieve the maximum potential yield or cover, topsoil is required on the 6300 dump. However, adequate cover can be achieved on sludge amended soils. No significant differences in vegetation cover and species richness were apparent between topsoiled areas of 6 inch and 12 inch depth, and visible differences in shoot yield were minimal. Therefore, it is recommended that, if topsoil is used, the depth need not exceed 6 inches. Further study may be undertaken to determine if a lower depth of topsoil impedes cover or species richness.

2.2 Fertilization

Throughout the trial period, compound 18-46-0 chemical fertilizer was found to be most effective in terms of enhanced vegetation cover, growth, and species richness. Urea formaldehyde promoted ruderal establishment from the soil seed bank during the early stages of colonization, leading to the competitive exclusion of several commercial species. Applications of ammonium nitrate and single super (calcium) phosphate induced delayed germination and establishment.

Therefore, 18-46-0 compound fertilizer normally would be recommended as a complete, single-application fertilizer.

Irrespective of which fertilizer was applied to topsoiled blocks, ruderal species within the soil seed bank were promoted to the exclusion of some commercial species. This is often observed when nitrogen-containing compounds are applied at about the same time as seeding. The rapid growth response of ruderal species, relative to commercial species, can be suppressed by applying nitrogen after vegetation has emerged. In this way, ruderal growth is limited by the already established commercial vegetation cover. To achieve this at the 6300 rock dump, it is recommended that phosphate is applied as single superphosphate before seeding, and if necessary, nitrogen and additional phosphate are applied as a topdressing of 18-46-0 compound fertilizer, approximately 6 to 8 weeks after commercial vegetation emergence. The following application rates are appropriate:

- Single superphosphate at 180 lb. acre; and,
- 18-46-0 at 310 lb./acre.

The nitrogen application provided by the 18-46-0 compound fertilizer would be made only if visual symptoms of nitrogen deficiency are evident (as yellowing of leaves).

2.3 Species Mixture

The species in the original reclamation mixture which did not perform satisfactorily included:

- *Agropyron smithii* (poor establishment);
- *Elymus elymoides* (poor establishment/competitive exclusion);
- *Poa canbyi* (poor establishment); and,
- *Astragalus cicer* (regression over time).

It is recommended that these species are removed from the reclamation mixture, and are replaced by the following species which have shown good establishment on other areas of waste rock and topsoil at the mine:

- *Agropyron intermedium* (intermediate wheatgrass);
- *Elymus cinereus* (Great Basin wildrye);
- *Festuca rubra* (Red fescue); and,
- *Achillea lanulosa* (Yarrow).

In addition to these commercial species, *Chrysothamnus nauseosus* and *Artemesia tridentata* should be included as native components.

The recommended seed mixture for the 6300 rock dump reclamation (with application rates) is given in Table 1, Section 4.3. The mixture shows reduced application rates for *Secale cereale* and *Medicago sativa*, both of which had a tendency to dominate cover under stressful environmental conditions, particularly during low rainfall months. Reductions in the application rates of both species is likely to reduce competitive dominance and promote greater species density on reclaimed land.

3.0 6400/6500 Rock Dump

Trial plots constructed on the 6400/6500 rock dump were aimed to determine the effects of surface amendments, slope and aspect on commercial vegetation performance. Results arising from one season's growth indicated that:

- The effects of seeding onto waste rock amended with organic matter were inconsistent, and promoted poor vegetation cover and species richness on some blocks. However, grass cover and yield were satisfactory in some organically amended areas;

- Vegetation growth, establishment, and diversity were satisfactory on all blocks capped with topsoil up to 6 inches in depth; and,

- For all topsoiled blocks, vegetation cover, species richness, and performance did not differ significantly between northerly and southerly slopes, and between angle of repose (1.5:1) and regraded (2:1) slopes.

The results of these trials suggest an immediate value of topsoil placement to a 6-inch depth, to achieve higher shoot yields and cover relative to establishing vegetation directly into waste rock amended with organic matter. However, some areas amended with organic sludge also supported acceptable cover. The results also demonstrated the ability of selected species to establish on angle of repose slopes. Therefore, it is recommended that, where practically possible and economically feasible, the 6300 rock dump slopes are graded to 2:1 and capped with 6 inches of topsoil, prior to vegetation establishment. However, in areas where access by heavy machinery is restricted, slopes should remain at 1.5:1, and be topsoiled and hydraulically seeded. This specification is currently recommended until further studies are conducted to compare seed and fertilizer mixture application rates to sludge and other organically amended waste rock.

4.0 Specifications Summary: 6300 Rock Dump Slopes and Surfaces

4.1 Surface Preparation

All surfaces scheduled for reclamation in 1995 should be ripped to a depth of 6 inches where practically possible, before topsoil placement. Ripping should be done horizontally, across slope, while dozer tracking should be done vertically, up and down slope, to reduce concentrated surface water flow.

Topsoil should be spread by dozer to an average depth of 6 inches. On slope angles of 2:1, dozer access will be possible. On angle of repose slopes, it is likely that topsoil would be distributed down-gradient, from crest to toe, by dozing stockpiled material over the crest.

Once topsoiled, the crest should be protected by a berm of 1 foot vertical height, to prevent surface water run-off, downslope. The upper surface of the dump should be graded to about 0.5 percent to 1.0 percent slope, to divert water away from the crest.

4.2 Fertilization

At least 2 weeks before seeding, topsoiled areas should be treated with single superphosphate at a rate of 180 lbs/acre. Superphosphate may be broadcast mechanically over the surface, or hydraulically sprayed.

Between 6 to 8 weeks after vegetation emergence, a topdressing of 18-46-0 compound fertilizer should be applied to the surfaces. This application may also be performed mechanically, or hydraulically.

Maintenance topdressings during the second and third years should be applied as necessary, and on the basis of visual symptoms of soil nutrient deficiencies.

4.3 Reclamation Species Mixture

The 6300 rock dump reclamation mixture is described in Table 1, with appropriate application rates. Seeding should be performed in early to mid-October, by mechanical broadcasting or hydraulic seeding.

TABLE 1

RECOMMENDED SPECIES FOR THE RECLAMATION OF WASTE ROCK AT BARNEYS CANYON MINE

Botanical Name	Variety	Common Name	Application Rate (lbs/acre) PLS
Agropyron intermedium	Tegmar	Intermediate wheatgrass	4.0
Agropyron spicatum	Secar	Bluebunch wheatgrass	4.0
Elymus cinereus	Trailhead	Great Basin wildrye	2.0
Festuca rubra	Pennlawn	Red fescue	3.0
Festuca ovina	Covar	Sheep fescue	2.0
Secale cereale	--	Cereal rye	2.0
Achillea lanulosa	--	Yarrow	2.0
Artemesia tridentata	--	Sagebrush	1.0
Chrysothamnus nauseosus	--	Rabbit brush	1.0
Medicago sativa	Vernal	Alfalfa	1.5
Melilotus officinalis	Yukon	Yellow sweet clover	1.5
Penstemon palmeri	Cedar	Palmer penstemon	1.0
Total Application Rate			25.0 lbs/acre

4.4 Erosion Control

Hydraulic seeding should be performed separately from hydromulching. It is recommended that approximately 200 pounds of silva fiber mulch is included with the seed application to act as a marking agent to aid even seed application. Following the seed application, 2,000 lbs/acre silva fiber mulch should be hydraulically applied, over the seed, with a plantago gum tackifier at 100 lbs/acre.

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